Microelectronics

- Neutron Transmutation Doping of Compound Semiconductors

Program: Microelectronics

Title: Neutron Transmutation Doping of Compound Semiconductors

Author: R.M. Lindstrom

Abstract: The selective addition of small amounts of doping elements to semiconductors can be done by using neutron capture, followed by beta decay, to transmute elements. New compounds are being explored, to exploit the experience gained in industry with silicon.

Purpose: Transmutation of silicon by nuclear reactions has become well established for the production of high-power rectifiers and other electronic devices. In this application, phosphorus is created by the capture of neutrons by ^{31}Si to make ^{32}Si, which decays to ^{32}P. Because silicon is transparent to neutrons, the phosphorus dopant is created uniformly through a large Si crystal. The process is also applicable to compound semiconductors.

Major Accomplishments: The same process as used for doping elemental silicon is applicable to 1:1 compound semiconductors. Recently, neutron transmutation doping (NTD) has been explored in two additional systems. In collaboration with North Texas State University and the NIST Center for Neutron Research, samples of $Hg_{0.8}Cd_{0.2}Te$ films on $Cd_{0.95}Zn_{0.05}Te$ substrates have been subjected to neutron irradiation. The goal is to transmute both Hg to Au and Te to As. A first experiment using neutron fluences of 1-2 x 10^{16} cm^{-2} showed that transmutation is feasible. The results of this experiment were published in *Physica E*. To study the effects of irradiation quantitatively, additional samples have been exposed to a pure thermal neutron flux for fluences of 3 x 10^{16} to 1.3 x 10^{17} cm^{-2}; this work has been reported at the US Workshop on the Physics and Chemistry of II-VI Materials, Chicago, 5-7 Oct 2004.

Impact: Experiments so far are preliminary, but the ability to dope GaN uniformly would presumably be as useful as NTD has proven to be in Si. The opacity of Cd to neutrons restricts NTD in this system to thin films, but this is precisely where the interest lies.

Future Plans: The future applications of this technology depend on the results of characterization measurements now underway in our partner institutions.